

WHAT IS CLAIMED IS:

1. A lithographic positioning device for positioning an object, comprising:
 - a first drive unit for positioning the object in a first direction within a first operating range, said first drive unit comprising a first part and a second part, the first part being connected to said object and movable relative to the second part;
 - a second drive unit for displacing said first drive unit in the first direction within a second operating range, said second drive unit comprising a first part connected to said second part of said first drive unit and movable relative to a second part of said second drive unit; and
 - a permanent magnet system comprising a first part connected to either of said object or said first part of said first drive unit and a second part connected to either said second part of said first drive unit or said first part of said second drive unit,
wherein said permanent magnet system is configured to generate a force for moving said object in the first direction, said force being a function of a relative position in the first direction of said object and said first part of said second drive unit.
2. A positioning device according to Claim 1, wherein said force is substantially zero for a first position of said first part of said first drive unit relative to said second part in the first direction inside the first operating range of said first drive unit.
3. A positioning device according to Claim 2, wherein said first position is in stable equilibrium.
4. A positioning device according to Claim 2, wherein said first position is in an unstable equilibrium.
5. A positioning device according to Claim 4, wherein a first derivative of the function with respect to the first direction is substantially zero for said first position.

6. A positioning device according to Claim 2, further comprising:
 - a first coil unit, associated with said first drive, that generates a force between said first part and said second part of said first drive unit; and
 - a second coil unit, associated with said second drive, that generates a force between said first part and said second part of said second drive unit; and
 - a control unit configured to control the positioning device in accordance with an acceleration/deceleration state and a constant velocity state,
 - wherein, under said acceleration/deceleration state, an acceleration or deceleration of said object along the first direction is achieved by controlling a current of said first and second coil units, and
 - wherein, under said constant velocity state, a substantially constant velocity of said object is achieved by controlling the current of said first and second coil units and substantially maintaining said permanent magnet system in said first position.
7. A positioning device according to Claim 1, wherein said first part of said permanent magnet system comprises a first permanent magnet and said second part comprises a ferromagnetic part.
8. A positioning device according to Claim 1, wherein said first part of said permanent magnet system comprises a first permanent magnet and said second part comprises a second permanent magnet.
9. A positioning device according to Claim 1, wherein said permanent magnet system further comprises a linear actuator for controlling the position of said first part of said permanent magnet system relative to said second part along the first direction.
10. A positioning device according to Claim 1, wherein said permanent magnet system is further configured to generate a force in a second direction between

said object and said first part of said second drive unit, said second direction being substantially perpendicular to said first direction.

11. A lithographic apparatus, comprising:
 - an illumination system configured to provide a beam of radiation;
 - a support structure configured to support a patterning device that imparts said beam of radiation with a desired pattern in its cross-section;
 - a substrate holder configured to hold a substrate; and
 - a projection system for projecting said patterned beam onto a target portion of said substrate; and
 - a positioning device configured to position said support structure, said positioning device comprising:
 - a first drive unit for positioning said support structure in a first direction within a first operating range, said first drive unit comprising a first part and a second part, the first part being connected to said support structure and movable relative to the second part;
 - a second drive unit for displacing said first drive unit in the first direction within a second operating range, said second drive unit comprising a first part connected to said second part of said first drive unit and movable relative to a second part of said second drive unit; and
 - a permanent magnet system comprising a first part connected to either of said support structure or said first part of said first drive unit and a second part connected to either said second part of said first drive unit or said first part of said second drive unit,
wherein said permanent magnet system is configured to generate a force for moving said support structure in the first direction, said force being a function of a relative position in the first direction of said support structure and said first part of said second drive unit.

12. A lithographic apparatus according to Claim 11, wherein said force is substantially zero for a first position of said first part of said first drive unit relative to

said second part in the first direction inside the first operating range of said first drive unit.

13. A lithographic apparatus according to Claim 12, wherein said first position is in stable equilibrium.

14. A lithographic apparatus according to Claim 12, wherein said first position is in an unstable equilibrium.

15. A lithographic apparatus according to Claim 14, wherein a first derivative of the function with respect to the first direction is substantially zero for said first position.

16. A lithographic apparatus according to Claim 12, further comprising:
a first coil unit, associated with said first drive, that generates a force between said first part and said second part of said first drive unit; and
a second coil unit, associated with said second drive, that generates a force between said first part and said second part of said second drive unit; and
a control unit configured to control the positioning device in accordance with an acceleration/deceleration state and a constant velocity state,
wherein, under said acceleration/deceleration state, an acceleration or deceleration of said support structure along the first direction is achieved by controlling a current of said first and second coil units, and
wherein, under said constant velocity state, a substantially constant velocity of said support structure is achieved by controlling the current of said first and second coil units and substantially maintaining said permanent magnet system in said first position.

17. A lithographic apparatus according to Claim 11, wherein said first part of said permanent magnet system comprises a first permanent magnet and said second part comprises a ferromagnetic part.

18. A lithographic apparatus according to Claim 11, wherein said first part of said permanent magnet system comprises a first permanent magnet and said second part comprises a second permanent magnet.

19. A lithographic apparatus according to Claim 11, wherein said permanent magnet system further comprises a linear actuator for controlling the position of said first part of said permanent magnet system relative to said second part along the first direction.

20. A lithographic apparatus according to Claim 11, wherein said permanent magnet system is further configured to generate a force in a second direction between said support structure and said first part of said second drive unit, said second direction being substantially perpendicular to said first direction.

21. A lithographic apparatus, comprising:

- an illumination system configured to provide a beam of radiation;
- a support structure configured to support a patterning device that imparts said beam of radiation with a desired pattern in its cross-section;
- a substrate holder configured to hold a substrate; and
- a projection system for projecting said patterned beam onto a target portion of said substrate; and
- a positioning device configured to position said substrate holder, said positioning device comprising:
 - a first drive unit for positioning said substrate holder in a first direction within a first operating range, said first drive unit comprising a first part and a second part, the first part being connected to said substrate holder and movable relative to the second part;
 - a second drive unit for displacing said first drive unit in the first direction within a second operating range, said second drive unit comprising

a first part connected to said second part of said first drive unit and movable relative to a second part of said second drive unit; and

a permanent magnet system comprising a first part connected to either of said substrate holder or said first part of said first drive unit and a second part connected to either said second part of said first drive unit or said first part of said second drive unit,

wherein said permanent magnet system is configured to generate a force for moving said substrate holder in the first direction, said force being a function of a relative position in the first direction of said substrate holder and said first part of said second drive unit.

22. A lithographic apparatus according to Claim 21, wherein said force is substantially zero for a first position of said first part of said first drive unit relative to said second part in the first direction inside the first operating range of said first drive unit.

23. A lithographic apparatus according to Claim 22, wherein said first position is in stable equilibrium.

24. A lithographic apparatus according to Claim 22, wherein said first position is in an unstable equilibrium.

25. A lithographic apparatus according to Claim 24, wherein a first derivative of the function with respect to the first direction is substantially zero for said first position.

26. A lithographic apparatus according to Claim 22, further comprising:
a first coil unit, associated with said first drive, that generates a force between said first part and said second part of said first drive unit; and
a second coil unit, associated with said second drive, that generates a force between said first part and said second part of said second drive unit; and

a control unit configured to control the positioning device in accordance with an acceleration/deceleration state and a constant velocity state,

wherein, under said acceleration/deceleration state, an acceleration or deceleration of said substrate holder along the first direction is achieved by controlling a current of said first and second coil units, and

wherein, under said constant velocity state, a substantially constant velocity of said substrate holder is achieved by controlling the current of said first and second coil units and substantially maintaining said permanent magnet system in said first position.

27. A lithographic apparatus according to Claim 22, wherein said first part of said permanent magnet system comprises a first permanent magnet and said second part comprises a ferromagnetic part.

28. A lithographic apparatus according to Claim 22, wherein said first part of said permanent magnet system comprises a first permanent magnet and said second part comprises a second permanent magnet.

29. A lithographic apparatus according to Claim 21, wherein said permanent magnet system further comprises a linear actuator for controlling the position of said first part of said permanent magnet system relative to said second part along the first direction.

30. A lithographic apparatus according to Claim 21, wherein said permanent magnet system is further configured to generate a force in a second direction between said substrate holder and said first part of said second drive unit, said second direction being substantially perpendicular to said first direction.

31. A device manufacturing method, comprising:
providing a substrate held by a substrate holder;
providing a beam of radiation using an illumination system;

imparting a desired pattern onto said beam of radiation by a patterning device supported by a support structure;

projecting said patterned beam of radiation onto a target portion of said substrate via a projection system; and

positioning said support structure via a positioning device by:

positioning said support structure in a first direction within a first operating range through a first drive unit, said first drive unit comprising a first part and a second part in which said first part is connected to said support structure and movable relative to said second part;

displacing said first drive unit in the first direction within a second operating range through a second drive unit, said second drive unit comprising a first part connected to said second part of said first drive unit and movable relative to a second part of said second drive unit; and

generating a force for moving said support structure in the first direction through a permanent magnet system, said permanent magnet system comprising a first part connected to either of said support structure or said first part of said first drive unit and a second part connected to either said second part of said first drive unit or said first part of said second drive unit,

wherein said force is a function of a relative position in the first direction of said support structure and said first part of said second drive unit.

32. A device manufacturing method, comprising:

providing a substrate held by a substrate holder;

providing a beam of radiation using an illumination system;

imparting a desired pattern onto said beam of radiation by a patterning device supported by a support structure;

projecting said patterned beam of radiation onto a target portion of said substrate via a projection system; and

positioning said substrate holder via a positioning device by:

positioning said substrate holder in a first direction within a first operating range through a first drive unit, said first drive unit comprising a first part and a second part in which said first part is connected to said substrate holder and movable relative to said second part;

displacing said first drive unit in the first direction within a second operating range through a second drive unit, said second drive unit comprising a first part connected to said second part of said first drive unit and movable relative to a second part of said second drive unit; and

generating a force for moving said substrate holder in the first direction through a permanent magnet system, said permanent magnet system comprising a first part connected to either of said substrate holder or said first part of said first drive unit and a second part connected to either said second part of said first drive unit or said first part of said second drive unit,

wherein said force is a function of a relative position in the first direction of said substrate holder and said first part of said second drive unit.